QUALITY OF SLEEP IN PATIENTS WITH POSTTRAUMATIC STRESS DISORDER

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ABSTRACT

Objective. To assess the characteristics and correlates of sleep problems in patients with lifetime posttraumatic stress disorder and ongoing sleep disturbance not due to obstructive sleep apnea or other diagnosed sleep disorders.

Sample. Twenty-six veterans receiving psychiatric care at the Minneapolis Veterans Affairs Medical Center in Minneapolis, Minnesota.

Data collection instruments. The Pittsburgh Sleep Quality Index, sleep logs, and actigraph along with three symptom ratings scales—posttraumatic checklist, clinician-administered posttraumatic stress disorder scale, and Beck Depression Inventory—were used.

Results. Univariate analysis associated three symptom complexes with poorer sleep quality: posttraumatic avoidance, posttraumatic hypervigilance, and depressive symptoms. Borderline trends also existed between worse sleep quality and more severe clinician-rated posttraumatic stress, more self-reported awakenings from sleep, and greater actigraphy-determined sleep duration. Using linear regression, only posttraumatic hypervigilance symptoms were associated with sleep quality.

Conclusion. Sleep quality among posttraumatic stress disorder patients in active treatment is worse

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in direct relation to more severe posttraumatic hypervigilance symptoms.

INTRODUCTION

This study describes the types of sleep complaints reported and observed in patients with lifetime posttraumatic stress disorder (PTSD) and chronic sleep disturbance not due to sleep-disordered breathing or other sleep disorders. Sleep disorders can interfere with work, exercise and recreation, interpersonal relationships, and instrumental activities, such as driving.[1] Sleep-related complaints in patients with PTSD include repetitive awakenings, nightmares, difficulty obtaining sufficient sleep, daytime sleepiness, and daytime dysfunction.[2–4]

Woodward et al[5] found altered cardiac autonomic status during sleep among patients with PTSD as compared to patients with panic disorder. Germain et al[6] suggested that the amygdala and medial prefrontal cortex could be playing roles in contributing sleep disturbances in PTSD patients.

Researchers have found conflicting results with respect to sleep complaints in PTSD.[7] One text on sleep disorders barely mentions PTSD.[8] Excessive daytime sleepiness, multiple awakenings, and other forms of sleep disturbance are neither universal concomitants nor core features of PTSD.[9,10] A greater proportion of PTSD patients with comorbid panic disorder complain of sleep-related problems when compared to patients with major depressive disorder (MDD), generalized anxiety disorder (GAD), or alcohol dependence.[11] Although sleep difficulties are reported as important symptoms in PTSD,[12] some studies using polysomnography and actigraphy,[13–15] do not demonstrate objective evidence of sleep disturbance in post-trauma survivors. Interestingly, some studies have reported elevated arousal thresholds to auditory stimuli, suggesting decreased sensitivity to external stimuli and probably more vulnerability to internal stimuli in patients with PTSD.[16,17] A meta-analysis of polysomnographic studies in PTSD concluded that sleep abnormalities exist but could be influenced by other mediators, such as age and depression.[18]

Despite these conflicting reports, most combat veterans and rape victims with PTSD, whom we studied for several months to a year with a daily life charting instrument, reported various sleep complaints.[19] Our subsequent study using actigraphs demonstrated that the majority of veterans with PTSD and sleep disturbance had shortened sleep times and/or increased awakenings.[20] In order to better understand sleep problems in people with lifetime PTSD and current sleep disturbance, we sampled a mixed group of patients with diverse comorbid disorders and treatment histories to reflect common clinical practice.

This study tested the following hypotheses:

1. Sleep quality is directly correlated with objective measures of sleep awakenings and sleep duration.
2. Severity of sleep problems is directly correlated with subjective assessment of sleep awakenings, sleep duration, and daytime sleepiness.
3. Severity of sleep problems is associated with increased depressive symptoms, but not posttraumatic symptoms.

METHODS

Sample. Study participants were veterans receiving care at the Minneapolis Veterans Affairs Medical Center (VAMC). They were recruited using hospital posters that invited participation in a study of sleep disturbances in patients receiving PTSD treatment. Inclusion criteria were 1) a lifetime diagnosis of PTSD and 2) a current sleep disturbance (e.g., difficulty getting to sleep or staying asleep, nightmares, awakening, lack of restful sleep). Patients were excluded if they had obstructive sleep apnea, psychosis, dementia, delirium, and/or homelessness. There were no restrictions by age, gender, race/ethnicity, medication, or comorbidity other than described previously. Patients who had symptoms of specific sleep disturbances (e.g., sleep-disordered breathing, restless legs) were excluded and were referred for polysomnography.

The original sample comprised 35 subjects. Eight of these 35 study participants were excluded for active psychosis, homelessness, or active substance dependence. Two participants did not complete the Pittsburgh Sleep Quality Index (PSQI) data, leaving 25 study participants.

Of 25 study participants, 22 were men. Twenty-four participants were Caucasian, and one participant was Native American. Three participants were never married, 10 divorced, one widowed, and 11 married. Ten were disabled, six were working full-time, five were unemployed, three were retired, and one was working part time. Two people were educated through grades 9 to 11, two were high school graduates, 12 had some college background, six were college graduates, and three were college graduates with additional professional degrees. Regarding current residence, 12 were living in family-of-marriage, eight alone, two in an institutional setting, one in family-of-origin, one living with friends, and one living at another residence. Sixteen of 25 had been in combat. One of the 25 veterans had recovered from PTSD and did not meet diagnostic criteria in the last year, but continued to have sleep disturbance. Only one of the demographic characteristics bore a statistical association with the Pittsburgh scale: more education was associated with lower Pittsburgh score, i.e., better sleep quality,
R=-0.41 (p=0.04).

Instruments. *Sleep Measures—PSQI Scale*. The self rated PSQI consists of 19. The scale includes seven subscales, each of which ranges from 0 (normal) to 3 (severe

symptoms). The scoring convention for those subscales with more than one item differs depending on the item, but still only ranges from 0 to 3. Each subscale contains from 1 to 9 items. The scoring paradigm is complex and differs among the subscales with more than one item. The total scale scores can range from 0 (no sleep symptoms, high sleep quality) to 21 (severe symptoms, poor sleep quality); higher scores indicated poorer sleep quality.[21]

The seven subscales include the following: 1) duration of sleep (1 item), 2) sleep disturbances (9 items), 3) sleep latency (2 items), 4) daytime dysfunction (2 items; see below), 5) habitual sleep efficacy (3 items), 6) subjective sleep quality (1 item), and 7) use of sleep medication (1 item).

Examples of the two items for "daytime dysfunction" are 1) "trouble staying awake" to conduct daily activities, with a frequency response ranging from 0 (not during the past month) to 3 (three or more times in the past week) and 2) "enthusiasm to get things done" with a severity response ranging from 0 (not a problem at all) to 3 (a very big problem).

A single item assesses use of sleep medication (prescribed or over-the-counter) by frequency, with 0 to 3 (0=not during the past month, 1=less than one a week, 2=once or twice a week, 3=three or more times a week).

Actigraphy. Actigraphs detect, measure, and record movement. They have a high correlation with polysomnographic studies of sleep and wakefulness.[22] Correlations for total sleep time between actigraphy and polysomnography have been high, in the range of 0.97.[23] Correlations for awakenings have been less consistent, with a tendency for actigraphy to under-record "quiet awakenings" detected with formal polysomnography.[23,24]

Patients were asked to wear the actigraphs on the nondominant wrist 24 hours per day, except during periods when in water (e.g., showering, bathing). The actigraphs used were octagonal basic, ultra, and advanced models manufactured by Ambulatory Monitoring, Inc. (Ardsley, New York); each provides the same measures. Participants wore the actigraphs throughout the study period, providing 7 to 14 24-hour cycles per participant; mean cycles per participant were 11.5 nights. Data from the actigraphs were downloaded for analysis using Action W software (Ambulatory Monitoring, Inc.). Actigraphy-based data used for this analysis included mean sleep time per participant and mean number of awakenings per night.

Study participants were required to wear the actigraph for 14 nights. Seven study participants adhered fully with instructions, providing 14 nights/days of actigraphic data. The remaining 14 study participants missed some days of data collection, most often due to forgetting to put the actigraph back on after bathing.

Sleep log. Study participants completed a daily paper-and-pencil sleep log that consisted of sleep duration in 15-minute segments and number of awakenings.

Epworth Sleepiness Scale. This measure determines daytime sleepiness based on the rating of eight items. The Epworth Sleepiness Scale[25] has shown good sensitivity for measuring sleepiness in a variety of settings and research paradigms.[1] Although this is not the only sleepiness scale in use,[26] the time parameters, items, and pilot study indicated that it would be the most useful test for this study. Participants rated how likely they would be to fall asleep in the following eight different real-life circumstances:

1. Sitting and reading
2. Watching television
3. Sitting inactive in a public place (e.g., movie theater, meeting)
4. Riding as a passenger in a vehicle
5. Lying down to rest in the afternoon when circumstances permit
6. Sitting and talking to someone
7. Talking quietly after a lunch without alcohol
8. In car, while stopped for a few minutes in traffic.

Each item was scored from 0 to 3 (0=never doze, 1=slight chance of dozing, 2=moderate chance of dozing, 3=high chance of dozing). The Epworth score consisted of adding the scores of the eight items, with each item weighted equally. Scores potentially ranged from 0 to 24. Correlation between the items and the total Epworth score in this study was 0.66 to 0.93 ($p<0.001$) for all the items.

Posttraumatic and depressive symptom scales. *Posttraumatic stress disorder checklist.* The Posttraumatic Stress Disorder Checklist (PCL) is a 21-item, self-reported questionnaire that assesses current posttraumatic symptoms.[27] It has three subscales, i.e., re-experiencing, avoidant, and hypervigilant.

Clinician-Administered PTSD Scale. The Clinician-Administered PTSD Scale (CAPS) is a structured interview-based measure comprising 30 items that correspond to the *Diagnostic and Statistical Manual of Mental Disorders Fourth Edition (DSM-IV)* criteria for PTSD.[28] The CAPS can be used to make a current (defined as "past month") or lifetime diagnosis of PTSD. Participants were administered the CAPS-DX (diagnosis version) at baseline to determine their inclusion into the study. The CAPS-SX (symptom version) was administered at the termination of the study. To be included in the study, participants had to have a lifetime diagnosis of PTSD.

Beck Depression Inventory. The Beck depression inventory (BDI) is a 21-item, multiple choice, self reported questionnaire used to assess current depressive symptoms.[29]

Data collection procedures. The PSQI scale, Epworth sleepiness scale, PCL, and BDI were administered before and after the

TABLE 1. Mean Pittsburgh Sleep Quality Index versus other sleep scales and symptom scales in 23 veterans with posttraumatic stress disorder and sleep disturbance

VARIABLE	CORRELATION WITH MEAN PITTSBURGH SCORE	
	Pearson r	Probability
Actigraphic Findings		
Sleep duration, mean	r=+0.37	*p*=0.08
Awakenings, mean	r=-0.23	*p*=0.30
Sleep Log		
Sleep duration, mean	r=-0.18	*p*=0.26
Awakenings, mean	r=+0.37	*p*=0.07
Epworth Sleepiness Items and Score		
Total Epworth score	r=-0.03	*p*=0.88
Symptom Scores		
PCL, total score	r=+0.36	*p*=0.07
PCL, hypervigilance	r=+0.42	*p*=0.04
PCL, avoidance	r=+0.41	*p*=0.04
PCL, re-experiencing	r=+0.19	*p*=0.38
Clinician-Administered PTSD Scale, current	r=+0.39	*p*=0.07
Beck Depression Inventory	r=+0.40	*p*=0.05

KEY: PCL=Posttraumatic Stress Disorder Checklist; PTSD: posttraumatic stress disorder

two-week period of actual sleep data collection (using actigraphy and a daily sleep log). The ratings used for this study consisted of an average of the baseline and terminal ratings for these four scales. Actigraphy and sleep log data collected throughout the two weeks consisted of mean nightly duration of sleep and mean number of awakenings per night.

Data analysis. The PSQI score was the dependent measure. Independent factors potentially effecting sleep quality were as follows:

1. Actigraphic duration of sleep and awakenings
2. Sleep log duration of sleep and awakenings
3. Mean Epworth sleepiness scale score
4. Total CAPS Scale score on entry into the study
5. Mean PCL scores (re-experiencing, avoidance, hypervigilance, and total)
6. Mean BDI scores.

Univariate analyses were conducted utilizing the Pearson correlation test. A linear regression analysis included all univariate analyses showing correlation at 0.10 or less. The variables were entered in a stepwise fashion.

FINDINGS

Analysis of PSQI. The PSQI is a 19-item, self-rated assessment questionnaire with higher scores indicating poor sleep quality. Mean PSQI scores were based on the scale at the beginning of two weeks and the end of two weeks divided by two. The 25 study participants had scores ranging from 7.5 to 18.7, with a median of 14.2, mean of 14.0, and standard deviation of 3.0. Skew was -0.36 and kurtosis was -0.42. Correlations between the items and the total PSQI score at the beginning of the study were as follows:

- High correlation: habitual sleep efficiency (r=+0.73, $p<0.001$), sleep latency (r=+0.72, $p<0.001$), duration of sleep (r=+0.63, $p<0.001$)
- Moderate correlation: use of sleep medication (r=+0.48, $p=0.02$), daytime dysfunction (r=+0.47, $p=0.02$)
- Borderline correlation: subjective sleep quality (r=+0.38, $p=0.07$), sleep disturbances (r=+0.34, $p=0.10$).

Correlations between the items and the total PSQI score two weeks later at the end of the study were as follows:

- High correlation: habitual sleep efficiency (r=+0.71, $p<0.001$), subjective sleep quality (r=+0.63, $p<0.001$)
- Moderate correlation: sleep latency (r=+0.53, $p=0.01$), duration of sleep (r=+0.52, $p=0.01$), daytime dysfunction (r=+0.40, $p=0.05$), sleep disturbances (r=+0.42, $p=0.04$)
- No correlation: use of sleep medication (r=+0.04, $p=0.84$).

Since daytime sleepiness can vary over time, we obtained a self rating of the PSQI Scale at entry into the

project (Pittsburgh/t1) and after two weeks (Pittsburgh/t2). We then added these two scores together and divided by two to obtain a mean Pittsburgh score (Pittsburgh/mean) for the two-week period. Correlation between Pittsburgh/t1 and Pittsburgh/t2 was r=+0.65, $p<0.001$. Correlation between Pittsburgh/t1 and Pittsburgh/mean was higher at r=+0.92, $p<0.001$; and correlation between Pittsburgh/t2 and Pittsburgh/mean was likewise high at r=+0.89, $p<0.001$. In sum, the combined Epworth score related very well to ratings at t1 and t2, although ratings at t1 and t2 related only moderately well to each other.

Pittsburgh Sleep Duration versus actigraphy versus sleep log. The Pittsburgh Sleep Duration subscale at t1 and the same scale at t2 were compared against the mean sleep durations obtained from actigraphy and the daily sleep log. The Pittsburgh Sleep Duration at t1 was not significantly associated with either the actigraphic data (r=0.14, p=0.55) or sleep log data (r=-0.39, p=0.07). However, the Pittsburgh t2 sleep duration was associated with the mean sleep log duration in the expected direction, i.e., less sleep log duration was correlated with more sleep disturbance on the Pittsburgh scale (r=-0.58, p=0.003), but not with the actigraphy sleep duration (r=+0.10, p=0.68). The separate Pittsburgh sleep disturbance scale scores at t1 and t2 were not associated with the actigraphy awakenings nor with the sleep log awakenings.

These findings confirm that the Pittsburgh sleep duration subscale at t2 did accurately reflect the study participant's subjective recall for the previous two weeks at p=0.003. However, the subscale at t1 did not predict subsequent subjective sleep experience very well (p=0.07). In addition, the sleep duration subscale was not confirmed by objective actigraphic data, either retrospectively or prospectively. The Pittsburgh sleep disturbance subscale showed no correlation with actigraphic awakenings or with sleep log awakenings at either t1 or t2.

TABLE 2. Linear regression analysis, stepwise method showing factors independently predicting the mean Pittsburgh Sleep Quality Index

VARIABLES	BETA	t	SIGNIFICANCE
CONSTANT	---	2.85	0.01
PCL hypervigilance, mean	0.455	2.34	0.03
EXCLUDED VARIABLES			
Education (years)	-0.229	-1.15	0.27
Actigraphic sleep duration, mean	0.290	1.50	0.15
Sleep log awakenings, mean	0.275	1.39	0.18
Beck Depression Inventory, mean	0.211	0.63	0.54
PCL, avoidance, mean	0.230	0.66	0.52

KEY: PCL=Posttraumatic Stress Disorder Checklist

Comparison of Pittsburgh sleep quality with sleep scales. *Actigraphy findings.* As shown in Table 1, shorter sleep duration on actigraph was associated with poor sleep quality on the PSQI at a borderline level of probability (p=0.08). However, awakenings per night was not associated with the mean Pittsburgh scores.

Sleep log reports. More awakenings per night on the sleep log were associated with poorer sleep quality on the PSQI to a borderline level of probability (p=0.07; Table 1). Sleep duration per night was not associated with the mean Pittsburgh sleepiness scores.

Epworth Sleepiness Scale. The PSQI scale score and the Epworth Sleepiness score were not correlated. However, of the six subscales within the scale, the two-item "daytime dysfunction" subscale was directly and strongly correlated with increased sleepiness at r=+0.67, $p<0.001$. In addition, the one-item sleep medication use was inversely correlated with sleepiness to a modest extent at r=-0.48, p=0.02, i.e., more daytime sleepiness was associated with more daytime dysfunction and less use of sleep medication.

Comparison of sleepiness with depressive and posttraumatic symptoms. *PCL.* The mean total PCL was correlated with the mean Epworth scores at r=+0.36, p=0.07. Among the three subscales, the PCL hypervigilance and PCL avoidance subscale were both correlated with Epworth scores at p=0.04. The PCL re-experiencing and PCL avoidance both showed nonsignificant correlations at r=+0.34, p=0.09.

CAPS. The CAPS was correlated with the mean Epworth scores at a borderline significance level of r=+0.36, p=0.09.

BDI. The mean Beck scores were directly correlated with the mean Epworth scores at borderline level of r=+0.40, p=0.05.

Linear regression, stepwise. The PSQI was the dependent variable for the linear regression. Independent variables, in order of stepwise entry, included years of education, mean duration of sleep on actigraphy, mean number of awakenings on the sleep log, the BDI score, the PCL hypervigilance score, and the PCL avoidance score. The CAPS was excluded from the analysis due to its similarity to the PCL. As shown in Table 2, only the PCL hypervigilance score showed an independent relationship to the Pittsburgh sleep quality scale when

all variables significant at 0.10 or less were considered.

DISCUSSION

Sleep quality and disturbance in PTSD. Patients presenting with PTSD commonly report difficulty with sleep. For example, 44 to 90 percent of combat veterans with PTSD report difficulty falling or staying asleep.[30] In addition, 52 to 87 percent report having repeated nightmares.[2] Thus, the participants in this study may be representative of patients (especially veterans) presenting with PTSD.

In this current study we found univariate relationships at a probability of 0.05 or less between sleep quality on the PSQI and hypervigilance and avoidance PTSD symptom complexes on the self-rated PCL and BDI. In addition, the PSQI had borderline relationships to clinician-rated scores on the CAPS (p=0.07), number of awakenings on the sleep log (p=0.07), and sleep duration on actigraphy (p=0.08). However, the linear regression analysis revealed that only the self-rated PCL hypervigilance scale bore a direct independent relationship to sleep quality on the PSQI, i.e., as the hypervigilance symptoms became greater, the sleep quality became worse.

Unfortunately, most studies of sleep disturbance in PTSD have examined the severity of PTSD symptoms overall[18] rather than selectively examining only hypervigilance symptoms. Combat veterans in general and people with PTSD whose trauma occurred at night in particular could be more apt to experience sleep disturbance in association with hypervigilance at night. For example, clinicians in VA settings often hear veterans report increased watchfulness and anxiety at night, when they need to "secure the perimeter" around their homes and maintain watchfulness to protect themselves and family members.

Polysomnagraph and actigraphic studies have inherent limitations with respect to subjective symptoms of hypervigilance. Other studies have not shown a correlation between objective measures of sleep and PTSD, including studies involving combat veterans from World War II[31] and from the Vietnam War.[13] Differences between these studies and our data could be due to one or more of the following:

- *Sampling differences:* Our study participants were all receiving treatment for PTSD, whereas other studies have included nonpatients or a mix of patients and nonpatients.[13,31]
- *Study instruments:* We employed actigraphy in the veteran's usual sleep setting, whereas other investigators have mostly used polysomnography in laboratory settings.[13,31]
- *Age of study participants:* Our population was older, and older people have a higher frequency of sleep disturbances due to lower sleep efficiency, shorter total sleep time, and greater frequency and duration of awakening after sleep onset, regardless of PTSD.[32]

Future studies utilizing power spectral analysis of electroencephalography and other autonomic measures may reflect more on objective sleep disturbances in patients with PTSD.

Potential limitations. Our study involved a small number of study participants, which increases the possibility of false negative findings. The number of women was limited (n=3), as was the number of non-Caucasians (n=1), making the study findings potentially less generalizable to people with a more diverse population. A large sample would permit more rigorous assessment of various demographic factors. Study participants were stable clinically; inclusion of acute or recent cases of PTSD might accentuate daytime sleepiness and sleep disturbance.

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